

MAR 22 2007

In the Claims

Claims remaining in the application are as follows:

1. (Currently Amended): A device capable of usage in a storage system including an initiator, a primary target, and a secondary target, the device being capable of configuration for asynchronous remote mirroring functionality and comprising:

- a target controller capable of communicating with the initiator and performing operations requested by the initiator; and
- a process on the target controller capable of receiving a stream of command requests from the initiator, performing the requested commands, and asynchronously relaying the requested commands to a secondary target while ensuring precedence graph equivalence between received and relayed commands, the process embedding task attributes in the relayed commands capable of increasing concurrency in commands performed by the secondary target, wherein the target controller is a Small Computer Systems Interface (SCSI) device and the task attributes are SCSI task attributes including Simple, Ordered, Head of Queue, and Auto Contingent Allegiance (ACA) task attributes.

2. (Currently Amended): The device according to Claim 1 further comprising: the target controller capable of communicating with the initiator and performing operations requested by the initiator as a primary target; and a process on the target controller that receives a command stream from the initiator that specifies task attributes describing an execution sequence order, and reconveys the commands and task attributes to the secondary target so that the execution order is the same in the primary target and the secondary target.

3. (Currently Amended): The device according to Claim 1 further comprising: a process on the target controller that receives a command stream from the initiator that omits specification of task attributes describing an execution sequence order, determines implied task attributes from the command stream based on ordinality ordering of tasks, and conveys the commands and implied task attributes to the

secondary target, enabling improvement in concurrency in command execution by the secondary target.

4. (Original): The device according to Claim 3 further comprising:

a process on the target controller that determines implied task attributes from the command stream further comprising:

a process that infers an intended precedence graph of a primary initiator by tracking concurrency of issued tasks; and

a process that conveys the inferred preference graph to the secondary target.

5. (Currently Amended): The device according to Claim 1 further comprising:

the target controller capable of communicating with the initiator and performing operations requested by the initiator as a primary target; and

a process on the target controller that determines implied task attributes from the command stream further comprising:

a process that responds to a transition from less than two outstanding write tasks to multiple outstanding write tasks by marking the multiple outstanding write tasks as Simple tasks.

6. (Original): The device according to Claim 1 further comprising:

a process on the target controller that determines implied task attributes from the command stream further comprising:

a process that responds to a transition from multiple outstanding write tasks to no outstanding write tasks by marking a subsequent write task as an Ordered task.

7. (Original): The device according to Claim 1 further comprising:

a process on the target controller that determines implied task attributes from the command stream further comprising:

a process that responds to a transition from multiple outstanding write tasks to no outstanding write tasks by inserting an Ordered no_op command and

tentatively marking a subsequent write task as an Ordered task, subject to demotion to a Simple task on subsequent multiple outstanding tasks.

8. (Original): The device according to Claim 1 further comprising:

a process on the target controller that determines implied task attributes from the

command stream further comprising:

a process that tracks an active number of write tasks for a nexus relating the initiator, targets, and logical units (LUNs);

a process responsive to no active write tasks that inserts a no-op command marked as Ordered in a precedence graph to be propagated to the secondary target;

a process responsive to no active write tasks that sets a no-op_inserted flag to zero;

a process responsive to no active write tasks and a no-op_inserted flag set to one that marks a new write task temporarily as an Ordered and promoted task;

a process responsive to no active write tasks and a no-op_inserted flag set to zero that marks a new write task as an Ordered task;

a process responsive to one active write task in which a promoted task exists that demotes the promoted task to a Simple task; and

a process responsive to at least one active write task that marks a new write task to a Simple task.

9. (Original): The device according to Claim 1 further comprising:

a process on the target controller that determines command attributes to ensure correct operation at the secondary target in the absence of the initiator supplying the attributes.

10. (Canceled)

11. (Currently Amended): A method of ordering commands in a communication

system comprising:

receiving a stream of commands;

performing the commands;

relaying the commands to a target;

embedding task attributes in the relayed commands to increase concurrency in
commands performed by the target wherein the task attributes are SCSI task
attributes including Simple, Ordered, Head of Queue, and Auto Contingent
Allegiance (ACA) task attributes; and

~~relaying the commands to a target~~

operating in a Small Computer Systems Interface (SCSI) device.

12. (Currently Amended): A method according to Claim 11 further comprising:
inferring an intended precedence of the ~~requested~~ commands; and
embedding task attributes in the relayed commands according to the intended precedence
to increase concurrency in commands performed by the target.

13. (Original): A method according to Claim 11 further comprising:
receiving a command stream that omits specification of task attributes describing an
execution sequence order;
determining implied task attributes from the command stream; and
conveying the commands and implied task attributes to enable improvement in
concurrency in commands performed by the target.

14. (Currently Amended): A method according to Claim 11 further comprising:
receiving at a primary target a command stream from ~~the~~ an initiator that specifies task
attributes describing an execution sequence order; and
reconveying the commands and task attributes from the primary target to the ~~a~~ secondary
target so that the execution order is the same in the primary target and the
secondary target.

15. (Currently Amended): A method according to Claim 11 further comprising:
tracking an active number of write tasks for a nexus relating ~~the~~ an initiator, a plurality
of targets, and a plurality of logical units;

responding to no active write tasks at a primary target by inserting a no-op command marked as Ordered in a precedence graph to be propagated to ~~the~~ a secondary target;

responding to no active write tasks by setting a no-op_inserted flag to zero;

responding to no active write tasks and a no-op_inserted flag set to one by marking a new write task temporarily as an Ordered and promoted task;

responding to no active write tasks and a no-op_inserted flag set to zero by marking a new write task as an Ordered task;

responding to one active write task in which a promoted task exists by demoting the promoted task to a Simple task; and

responding to at least one active write task by marking a new write task to a Simple task.

16. (Currently Amended): The method according to Claim 11 further comprising: determining command attributes to ensure correct operation in the absence of ~~the~~ an initiator supplying the attributes.

17. (Original): The method according to Claim 11 further comprising: tracking concurrency of issued tasks; inferring an intended precedence graph based on the tracked tasks; and applying Ordered and Simple task attributes to a stream of pipelined commands to convey a precise execution sequence order for issued commands according to the inferred precedence graph to improve command execution efficiency.

18. (Canceled)

19. (Original): The method according to Claim 11 further comprising: relaying commands in a remote asynchronous mirroring application.

20. (Original): A method of ordering commands in a communication system comprising: communicating information via an internet Small Computer Systems Interface (iSCSI) transport protocol; and

embedding Small Computer Systems Interface (SCSI) task attributes in a received command stream to ensure an ordering behavior sufficient for attaining concurrency performance and correct algorithm operation.

21. (Currently Amended): A method of ordering commands in a communication system comprising:

receiving a stream of command requests;

relaying the requested commands; and

embedding task attributes in the relayed commands to improve transaction ordering for a remote mirroring application using an ordered transport; ~~and~~

~~relaying the requested commands wherein the task attributes are SCSI task attributes including Simple, Ordered, Head of Queue, and Auto Contingent Allegiance (ACA) task attributes.~~

22. (Currently Amended): An article of manufacture comprising:

a controller usable medium having a computable ~~readable~~ program code embodied therein for ordering commands in a communication system, the computable ~~readable~~ program code further comprising:

a code capable of causing the controller to receive a stream of command requests;

a code capable of causing the controller to perform the requested commands;

a code capable of causing the controller to infer an intended precedence of the requested commands;

a code capable of causing the controller to relay the requested commands to a target; and

~~a computable-readable program~~ code capable of causing the controller to embed task attributes in the relayed commands according to the intended precedence to increase concurrency in commands performed by the target; ~~and~~

~~a code capable of causing the controller to relay the requested commands to a target wherein the task attributes are SCSI task attributes including~~

Simple, Ordered, Head of Queue, and Auto Contingent Allegiance (ACA) task attributes.

23. (Currently Amended): An article of manufacture comprising:
a controller usable medium having a computable ~~readable~~ program code embodied therein for ordering commands in a communication system, the computable ~~readable~~ program code further comprising:
a code capable of causing ~~the~~ a controller to communicate information via an internet Small Computer Systems Interface (iSCSI) transport protocol;
and
a code capable of causing the controller to embed Small Computer Systems Interface (SCSI) task attributes in a received command stream to ensure an ordering behavior sufficient for attaining concurrency performance and correct algorithm operation.
24. (Currently Amended): An article of manufacture comprising:
a controller usable medium having a computable ~~readable~~ program code embodied therein for ordering commands in a communication system, the computable ~~readable~~ program code further comprising:
a code capable of causing ~~the~~ a controller to receive a stream of command requests;
a code capable of causing the controller to relay the requested commands; and
a code capable of causing the controller to embed task attributes in the relayed commands to improve transaction ordering for a remote mirroring application using an ordered transport wherein the task attributes are SCSI task attributes including Simple, Ordered, Head of Queue, and Auto Contingent Allegiance (ACA) task attributes.
25. (Currently Amended): A device in a communication system comprising:
means for receiving a stream of command requests;
means for performing the requested commands;
means for relaying the requested commands to a target; and

means for embedding task attributes in the relayed commands capable of increasing concurrency in commands performed by the target; and
~~means for relaying the requested commands to a target wherein the task attributes are~~
SCSI task attributes including Simple, Ordered, Head of Queue, and Auto Contingent Allegiance (ACA) task attributes.

26. (Currently Amended): A remote mirroring method comprising:
communicating information between a primary initiator and a secondary target;
inferring a task precedence graph intended by the primary initiator by tracking concurrency of issued tasks; and
conveying the inferred task precedence graph to the secondary target; and
sensing the inferred task precedence graph by tracking transition points dependent on
ordering of commands in a command stream wherein tracking transition points
further comprises:
switching at a first transition point from a multiple outstanding write task
condition to a no outstanding write task condition; and
switching at a second transition point from one or fewer outstanding write tasks
to multiple outstanding write tasks.

27. (Canceled)

28. (Canceled)

29. (Currently Amended): The remote mirroring method according to Claim 28 26
further comprising:

inferring the intended task precedence graph comprising:
marking multiple outstanding tasks at the second transition point as Simple tasks;
marking a first task following the first transition point as an Ordered no-op
command; and
marking as Ordered all commands issued by the initiator in a sequence.

30. (Original): The remote mirroring method according to Claim 29 further comprising:

after marking the no-op command:

tentatively marking a first task following the first transition point as Ordered,
wherein the marked Ordered task is demoted to a Simple task when the
number of outstanding commands exceeds one.